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## Plant invasion following fires

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The relationship of plants to burned-over areas has received comparatively little attention by American botanists. As an ecological problem it seems to me that this offers a number of interesting possibilities. It is for this reason, and because of the apparently unusual attendant circumstances, that two recent papers by Torrey[1] appearing in this journal are of particular interest. These had to do with wide spread invasions by *Marchantia* following forest fires. We are comparatively well acquainted with *Chamaenirion*, a pyrophilous plant found commonly about the entire north temperate region, and the lodgepole pine of our western states, but information regarding the plant invasion and sequence of development upon eastern burns is fragmentary.

It would seem—and this is offered as a suggestion and with the hope that someone will follow it up with their notes and observations—that burns resulting from the firing of piled slash or piles of railroad ties offer an excellent opportunity for gathering interesting ecological data. This would be particularly true if carried out through a sufficient length of time. A comparison of several such localities with differing soil, moisture and floristic conditions should prove an attractive problem. One does not always need a large area to develop data of a worth while nature.

It may be said that in general the soil of such localities re-

[1] Torrey, R. H. *Marchantia polymorpha* after forest fires. Torreya **32**: 9–10, 1932.

Torrey, R. H. Another report of *Marchantia polymorpha* after forest fires. Torreya **32**: 128–129. 1932.

mains bare of vegetation through the first season following the intense heat of a high brush pile. During the next season one is likely to find certain members of the moss group starting their invasion near the periphery, and possibly small scattered colonies starting in other portions. Frequently a few discomycetous fungi are also found. These are usually scattered about the interior of the circle. A close inspection may even disclose members of other divisions of the fungous group.

Among the early invaders one will usually find such moss genera represented as *Bryum*, *Ceratodon* and *Funaria*, with possibly *Polytrichum* as a later arrival in dry localities. Among the fungi one would naturally expect to find *Pyronema confluens* appearing as the most common example. Such others as *Ascobolus carbonarius*, *Geopyxis cupularis*, *Peziza pustulata*, *Peziza violacea* and *Rhizinia inflata* may be encountered, and there is always the chance of making new acquaintances.

The following season the mosses usually become more generally dispersed over the plot, and flowering plants may begin their invasion. This latter naturally begins near the margin of the area, where the effect of the fire has possibly not been so great. A few casuals may be seen among the earlier moss patches in the inner portion. It must be recognized, however, that any sequence of events is easily altered by varying conditions of locality.

With different soil, moisture, acidity and temperature factors retardation or hastening of plant development may be expected. These factors also regulate the sequence in the series of plants to develop prior to reëstablishment of the pre-fire state. An open sand or compact clay soil, a naturally dry or damp situation, a hollow, a knoll or a sloping hillside will each tend to induce variation. Sufficient moisture and adequate drainage are important aids in hastening revegetation, provided they operate in proper conjunction with one another.

Seaver and Clark[2] and Seaver[3] have shown that intense heat may materially increase the soluble matter in the soil, and that flowering plants may be retarded in their growth by this con-

[2] Seaver, F. J. and Clark, E. D. Biochemical studies of soils subjected to dry heat. Bioch. Bull. **1**: 413–427, *pl. 7*. 1912.

[3] Seaver, F. J. North American Cup-fungi. 1–284, *pls. 1–45+figs. 1–15*. 1928.

centrate. On the other hand, it is comparatively well known that many cryptogamous plants are able to adapt themselves to the presence of such concentrates, and sometimes are even favored by their presence. This is particularly true among the fungi, and to a lesser extent among the bryophytes. When we consider the flowering plants one finds the number tolerant to a pyrophilous condition greatly reduced.

The importance of good drainage as an aid to rapid revegetation is quite evident from the preceding suggestion. If the soluble concentrates produced by the fire are rapidly leached away reversion, with a steady and progressive plant invasion, will take place. But if, on the other hand, these concentrates are held in the soil a retardation of plant development is to be expected.

I have personally observed several instances of mass invasion by *Marchantia polymorpha* following forest fires in the Rocky Mountain region of western Montana. These invasions occurred in closely protected mountain meadows that were surrounded by steep slopes, and at elevations of from 3,500 to 6,500 feet. In each case they followed severe fires that completely denuded the meadow areas and scattered desolation over hundreds of acres through the hills.

In order to effect such a wholesale invasion as occurred in these instances, where an acre or more was covered with a practically pure stand of *Marchantia*, two important factors seemed very essential. These necessary factors are the presence of a considerable amount of humus and a soil having a high moisture content during the period of growth and reproduction. The mountain meadows to which I have referred had a deep gravelly soil that contained a large quantity of humus. Deep snow fields and the early rains of spring convert these into marsh-meadows during the early growing season. Fall rains supply sufficient moisture to insure fall growth and the development of spore producing organs. The excessively dry summers of this region, though causing a temporary dormancy, are apparently no deterrent to the ultimate growth of this plant. *Marchantia* is peculiarly adapted to withstand excessive dryness in its vegetative state, and recovers a normal condition quickly with a renewal of humid conditions. It should be noted here that *Marchantia* was not found on the adjacent, steep, gravelly slopes.

Another paper[4] is to appear shortly in which the invasion of these marsh-meadows is discussed in more detail.

There appeared a very sharp distinction between revegetation as it was taking place in the marsh-meadows and the slopes of the surrounding hills. In the former grasses were beginning to make their appearance during the second season after the fire, and the trend appeared to be very definitely toward a natural resumption of the pre-fire condition. Upon the adjacent slopes *Chamaenirion* was a dominant feature among the few invading species tolerant of the situation. Among these plants, and protected by their shade, young seedlings of the lodgepole pine were present in great numbers. Previous to the time of the fire these forested hillsides were dominated by the characteristic Douglas fir and larch association that had been typical of the several localities. This change is illustrative of the natural forest replacement in this portion of our Rocky Mountains. Return of both Douglas fir and larch is slow, and the lodgepole pine persists for a considerable period before being finally replaced.

The lodgepole pine proves to be the natural intermediary in the west between the devastation of a forest fire and the return to the normal conditions characteristic for the region. It is a tall, straight, slender tree and generally grows in very dense stands that are difficult to penetrate.

Those of us who have been so fortunate as to spend some time in any of our western national parks are aware that the western guide has a ready answer for most questions of the uninitiated. In a "flora" of one of the northern Rocky Mountain districts published not so very long ago it was explained that the common name of this tree was given it because of the fact that the tree is easily blown over and being in such dense stands they naturally lodge against one another. While this statement may be ecologically true as to the tree it is an historical error with respect to the name. The straight, slender, light weight poles were formerly held in high esteem by the aborigines of the region who made use of them as travois poles and poles for their tepees or lodges. The name seems to have been first used among the early trappers and before the actual opening up of

[4] Graff, P. W. Invasion by *Marchantia polymorpha* following forest fires. Bull. Torr. Bot. Club.

the country. It was first applied to the cut poles and later to the trees that produced them.

The lodgepole pine is well adapted to initiate natural reforestation upon these mountain slopes. It is capable of making its start beneath the shade of a few well chosen herbaceous plants which it soon overshadows and supplants as the dominating feature of the landscape. It, in turn, produces a dense shade beneath which the earlier natural stand may return slowly but ultimately to the region. Beneath the lodgepole it is possible for seedlings of the larch and Douglas fir to make their start, but only after the lodgepole has reached the size of early maturity and natural thinnings have appeared.

Small burns and large areas each have their special interest in relation to vegetation. While the larger areas may appear more attractive, the smaller are in reality no less so if studied intensively. The results attained from a study of either may be of equal botanical importance.

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